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Response of different propagation methods on growth attributes of water spinach (*Ipomoea aquatica* Forsk.)

Prachi Minj, Jitendra Singh, Versha Kumari and Rekha Singh

Abstract
A field experiment was carried out in the field of Pt. KLS College of Horticulture and Research Station, Rajnandgaon (C.G.) year 2021-22, under Vegetable Science Department with a view to study the "Response of different Propagation Methods on growth attributes of Water Spinach (*Ipomoea aquatica* Forsk.)". The crop Water spinach of variety Kalmi Reshmi were used to grown in nine treatments with 3 replications in a Randomized Block Design (RBD). The soil of experimental field was sandy clay soil. The PGR and biofertilizer used in the experiment were GA_3 100 ppm and *Trichoderma viride* 2 ml/L water as per the treatment and inorganic fertilizer content in dose of NPK (75:50:75 kg NPK/ha) in 9 treatments *viz.*, T_1: Planting through cuttings of 15 cm length treated with GA_3 (100 ppm), T_2: Planting through cuttings of 15 cm length treated with *Trichoderma viride* 2 ml/l water, T_3: Planting through cuttings of 15 cm length without treatment, T_4: Planting through seedlings treated with GA_3 (100 ppm), T_5: Planting through seedlings treated with *Trichoderma viride* 2 ml/l water, T_6: Planting through seedlings without treatment, T_7: Direct sowing of seeds treated with GA_3 (100 ppm), T_8: Direct sowing of seeds treated with *Trichoderma viride* 2 ml/l water and T_9: [Control] Direct sowing of seeds without treatment. The result revealed that maximum No. of established plants/plot (71.33), Vine Length (cm) (32.20 cm), Number of Leaves/plant (128.07), Leaf Length (cm) (11.65 cm), Leaf Width (cm) (2.72 cm), Petiole Length (cm) (7.50 cm), Inter nodal Distance (cm) (1.30 cm), Number of Vines/plant (20.60), Days to 1st cutting (30.00), Fresh Weight of Foliage/plant (gm) (104.10 gm), Dry Weight of Foliage/plant (gm) (20.61 gm) and Dry Matter Percentage of Foliage (19.80) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm), while the minimum was noticed in treatment T_9 ([Control] Direct sowing of seeds without treatment). On the basis of present experiment, treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) was found significantly superior for all the growth parameters of water spinach (*Ipomoea aquatica* Forsk.). Hence, it can be concluded for cultivation of water spinach.

Keywords: Water spinach, Kalmi Reshmi, green foliage yield**,** randomized block design, *Trichoderma viride*, NPK, GA_3, clay soil and seedlings treated

Introduction
Water spinach (*Ipomoea aquatic* Forsk) is herbaceous, perennial, vascular semi-aquatic plant belonging to the family Convolvulaceae with chromosome no. 2n = 30. It is locally known as Karmatta bhaji, kalmisaag and paani palak. Water spinach is a native to tropics and subtropics that grow wild and cultivated form in Southeast Asia, India and Southern China. It is believed that water spinach have been originated in China (Umar *et al.*, 2007; Ediee and Ho 1969) [13, 6]. In Chhattisgarh, water spinach is grown in all three Agro-climatic zones, *i.e.* Northern hills, Chhattisgarh plains and Bastar plateau. In Chhatisgarh, water spinach is cultivated in Dhamtari, Raipur, Ambikapur, Kondagaon, Bastar, Mahasamund, Bilaspur, Gariyaband, Durg and Kanker districts. There is no improved variety available in government and private sector. The cultivators rely upon the local genotypes, collect them from ponds and directly sell it to market. Bio-fertilizers and Plant growth regulators with different planting methods can play a key role in many metabolic pathways affecting seed germination, stem and root elongation as well as leaf expansion. One of the chemical treatments used to improve germination is the application of some growth regulators, such as gibberellic acid (GA_3) (Salisbury and Ross, 2000) [12]. External applications of GA_3 enhance seed germination (EL-Barghathi and EL-Bakosh, 2005) [7]. *Trichoderma viride* being both a bio-fertilizer and a bio-fungicide, proves to be a panacea to all agricultural problems. It improves overall plant health, by creating a positive environment with symbiotic relationship with plants and releases various types of secondary metabolites including, growth hormones, endochitinase, proteolytic enzymes and benefits the plants by taking advantage of plant-microbe interactions (Benítez *et al.*, 2004) [1].

Materials and Methods

The experiment was carried out in the field of Pt. KLS College of Horticulture and Research Station, Rajnandgaon (C.G.). Rajnandgaon is located in central plane of Chhattisgarh at latitude 21.10° N, and longitude 81.03° E and an altitude of 330.70 meter above sea level. Rajnandgaon district comes under Sub-tropical climatic region. The soil of experimental field was sandy clay soil. The soil was neutral in reaction, medium in organic carbon, low in nitrogen and medium in phosphorus and potash content.

The PGR and biofertilizer used in the experiment were GA_3 100 ppm and *Trichoderma viride* 2 ml/L water as per the treatment and inorganic fertilizer content in dose of NPK (75:50:75 kg NPK/ha). Most of the insects that can affect water spinach production are leaf miners, and most of them can be treated at the larval stage. Application of Profenofos 40% + cypermethrin 4% EC was sprayed 2-3 times throughout the growing season when damage persisted. The observations on growth parameters of the water spinach were recorded by tagging five randomly selected plants and their average values were calculated.

Results and Discussion

Data pertaining to growth parameters are influenced by 09 treatments has been given in Table 1 and Fig 1 to 12.

Number of established plants/plot ranges between 25.67 to 71.33. The maximum number of established plants/plot (71.33) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was found at par (64.00) in treatment T_5 (Planting through seedlings treated with *Trichoderma viride* 2 ml/l water), while the minimum number of established plants/plot (25.67) was recorded in treatment T_9 (Control: Direct sowing of seeds without treatment). The reason behind maximum number of established plants/plot is GA_3 activates alfa amylase enzyme in seed which helps in breakdown of stored food material of seeds which enhance the seed germination and root growth. While in case of cutting it helps in development of root and it grows along with incase in inter nodal length. Similar results were also observed by Pandey *et al.,* (2019) [8-9].

Vine length ranges between 13.80 to 32.20 cm. The maximum vine length (32.20 cm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was followed by in treatment T_5 (Planting through seedlings treated with *Trichoderma viride* 2 ml/l water), while the minimum vine length (13.80 cm) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). This result was obtained due to the fact that GA_3 enhance metabolic activity that promotes better development in elongation of shoots and vines by increase in rate of cell division and multiplication, which boosts the growth of vines. Also, similar results were reported by Chandrakar *et al.,* (2020) [4].

Number of leaves/plant ranges between 59.67 to 128.07. The maximum number of leaves/plant (128.07) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was followed by in treatment T_1 (Planting through cuttings of 15 cm length treated with GA_3 100 ppm), while the minimum number of leaves/plant (59.67) was recorded in treatment T_9 (Control: Direct sowing of seeds without treatment). The treatment planting through seedlings treated with GA_3 resulted in more numbers of leaves. The possible reason behind this is that the GA_3 enhances metabolic activity resulted in vigorous growth of leaves along with more nutrient mobility towards the plant, which leading to the formation of new leaves. Also, similar results were reported by Chouhan *et al.,* (2017).

Leaf length ranges between 9.88 cm to 11.65 cm. The maximum leaf length (11.65 cm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was found at par with treatment T_1 (Planting through cuttings of 15 cm length treated with GA_3 100 ppm) (11.31 cm), while the minimum leaf length (9.88 cm) was recorded in treatment T_9 (Control: Direct sowing of seeds without treatment). The maximum leaf length result was obtained due to the fact that GA_3 promotes nutrient mobility, cell division, cell elongation, cell wall plasticity, and cell membrane permeability, all of which contribute to increase the growth of plants. Similar result was also reported by Chandrakar *et al.,* (2020) [4].

Leaf width ranges between 1.28 cm to 2.72 cm. The maximum leaf width (2.72 cm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was found at par with treatment T_1 (Planting through cuttings of 15 cm length treated with GA_3 100 ppm) (2.44 cm), while the minimum leaf width (1.28 cm) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The highest leaf width might be due to GA_3 that increase the rate of cell multiplication and cell division in the plant and leaf expansions, resulting in an increase in leaf width. Also, similar results were reported by Chauhan *et al.,* (2017) [5].

Petiole length ranges between 4.30 cm to 7.50 cm. The maximum petiole length (7.50 cm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was found at par with treatment T_1 (Planting through cuttings of 15 cm length treated with GA_3 100 ppm) (6.00 cm), while the minimum petiole length (4.30 cm) was noticed in treatment T_9 ([Control] Direct sowing of seeds without treatment). GA_3 and *Trichoderma viride* provides a better growth and development to the plant, resulting in better nutrient availability to the photo synthetically functional leaves, which increase the petiole length. Also, similar results were reported by Chandrakar *et al.,* (2020) [4].

Inter nodal distance ranges between 1.00 cm to 1.30 cm. The maximum inter nodal distance (1.30 cm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was found at par with treatment T_1 (Planting through cuttings of 15 cm length treated with GA_3 100 ppm) (1.27 cm), while the minimum inter nodal distance (1.00 cm) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The higher inter nodal distance were recorded in the seedlings treated with GA_3. The increase in nodal distance might be due to GA_3 which increase the rate of cell multiplication and nutrient availability of the plant, resulting in an increase in inter nodal length. Similar results were also observed by Chandrakar *et al.,* (2020) [4].

Number of vines/plant ranges between 9.85 to 20.60. The maximum number of vines/plant (20.60) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was followed by treatment T_1 (Planting through cuttings of 15 cm length treated with GA_3 100 ppm), while the minimum number of vines/plant (9.85) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The increase in number of vines might be because GA_3 increase the number of secondary branches, which might be owing to its effect on promoting cell division, cell elongation, cell wall plasticity, cell membrane permeability and accumulation of assimilates, all of which contribute to increased number of vines per plant. Similar results were also observed by Chandrakar *et al.,* (2020) [4].

Days to 1stcutting ranges between 40.00 to 30.00. The minimum days to 1stcutting (30.00) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100

ppm) which was found at par with treatment T_5 (Planting through seedlings treated with *Trichoderma viride* 2 ml/l water) (32.10), while the maximum days to 1st cutting (40.00) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The minimum days to 1st cutting was reported in planting through seedlings treated GA_3 due to vigorous growth of vine length, inter nodal length and increase number of leaves. Similar results were also observed by Yesuf *et al.,* (2021) [14].

Fresh weight of foliage/plant ranges between 39.40 to 104.10 gm. The maximum fresh weight of foliage/plant (104.10 gm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was followed by treatment T_5 (Planting through seedlings treated with *Trichoderma viride* 2 ml/l water), while the minimum fresh weight of foliage/plant (39.40 gm) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The increase in fresh weight of foliage per plant is attributed to the fact that the GA_3 and *Trichoderma viride* provides a better growth and development to the plant, resulting in better nutrient availability towards plants and accumulation of assimilates. The results obtained in the present study are supported by the works of Pandey *et al.,* (2019) [8-9].

Dry weight of foliage/plant ranges between 6.77 to 20.61 gm. The maximum dry weight of foliage/plant (20.61 gm) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was followed by treatment T_5 (Planting through seedlings treated with *Trichoderma viride* 2 ml/l water), while the minimum dry weight of foliage/plant (6.77 gm) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The highest dry weight of foliage is recorded in planting through seedlings treated with GA_3, it is due to the decrease in moisture loss of plant. It also depends on days to cutting of water spinach. Similar results were also observed by Chauhan *et al.,* (2017) [5].

Dry matter percentage of foliage ranges between 17.17 to 19.80. The maximum dry matter percentage of foliage (19.80) was recorded under the treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) which was followed by treatment T_7 (Direct sowing of seeds treated with GA_3 100 ppm), while the minimum dry matter percentage of foliage (17.17) was noticed in treatment T_9 (Control: Direct sowing of seeds without treatment). The highest dry matter percentage of foliage was recorded in planting through seedlings treated with GA_3 is due to the foliage production and decrease in moisture loss of plant. The results obtained in the present study are supported by the works of Chandrakar *et al.,* (2020) [4].

Table 1: Growth parameters of Water Spinach (*Ipomoea aquatic* Forsk.).

Tr. No.	Treatment details	Number of established plants/plot	Vine Length (cm)	Number of Leaves/ plant	Leaf Length (cm)	Leaf Width (cm)	Petiole Length
T1	Planting through cuttings of 15 cm length treated with GA3 (100 ppm).	60.00	21.10	120.27	11.31	2.44	6.00
T2	Planting through cuttings of 15 cm length treated with *Trichoderma viride* 2 ml/l water.	53.00	20.05	74.07	11.10	2.09	5.54
T3	Planting through cuttings of 15 cm length without treatment.	34.67	14.20	62.00	10.41	1.87	4.85
T4	Planting through seedlings treated with GA3 (100 ppm).	71.33	32.20	128.07	11.65	2.72	7.50
T5	Planting through seedlings treated with *Trichoderma viride* 2 ml/l water.	64.00	24.86	88.00	11.11	2.16	5.75
T6	Planting through seedlings without treatment.	35.00	14.75	64.80	10.27	1.85	5.20
T7	Direct sowing of seeds treated with GA3 (100 ppm).	48.00	15.50	68.40	10.71	1.96	5.40
T8	Direct sowing of seeds treated with *Trichoderma viride* 2 ml/l water.	38.67	15.25	68.13	9.96	1.56	5.35
T9	[Control] Direct sowing of seeds without treatment.	25.67	13.80	59.67	9.88	1.28	4.30
SEm (±)		3.03	1.79	1.55	0.38	0.27	0.55
CD (5%)		9.10	5.36	4.66	1.16	0.80	1.64
CV (%) =		10.99	16.24	3.31	6.24	23.30	17.12

Tr. No.	Treatment details	Inter nodal Distance (cm)	Number of Vines/ plant	Days to 1st cutting	Fresh Weight of Foliage/ plant (gm)	Dry Weight of Foliage/ Plant (gm)	Dry Matter Percentage of Foliage
T1	Planting through cuttings of 15 cm length treated with GA3 (100 ppm).	1.27	16.20	31.20	86.21	15.66	18.17
T2	Planting through cuttings of 15 cm length treated with *Trichoderma viride* 2 ml/l water.	1.16	13.40	33.50	61.28	11.28	18.40
T3	Planting through cuttings of 15 cm length without treatment.	1.05	9.93	39.01	40.11	7.13	17.81
T4	Planting through seedlings treated with GA3 (100 ppm).	1.30	20.60	30.00	104.10	20.61	19.80
T5	Planting through seedlings treated with *Trichoderma viride* 2 ml/l water.	1.23	14.55	32.10	91.40	16.31	17.88
T6	Planting through seedlings without treatment.	1.08	11.50	37.80	47.33	8.42	17.76
T7	Direct sowing of seeds treated with GA3 (100 ppm).	1.20	15.53	35.05	69.32	12.96	18.69
T8	Direct sowing of seeds treated with *Trichoderma viride* 2 ml/l water.	1.12	12.34	36.52	50.69	9.27	18.30
T9	[Control] Direct sowing of seeds without treatment.	1.00	9.85	40.00	39.40	6.77	17.17
SEm (±)		0.06	0.81	1.13	2.35	0.38	0.30
CD (5%)		0.19	2.42	3.37	7.05	1.14	0.92
CV (%) =		9.51	10.16	3.54	6.21	5.48	2.92

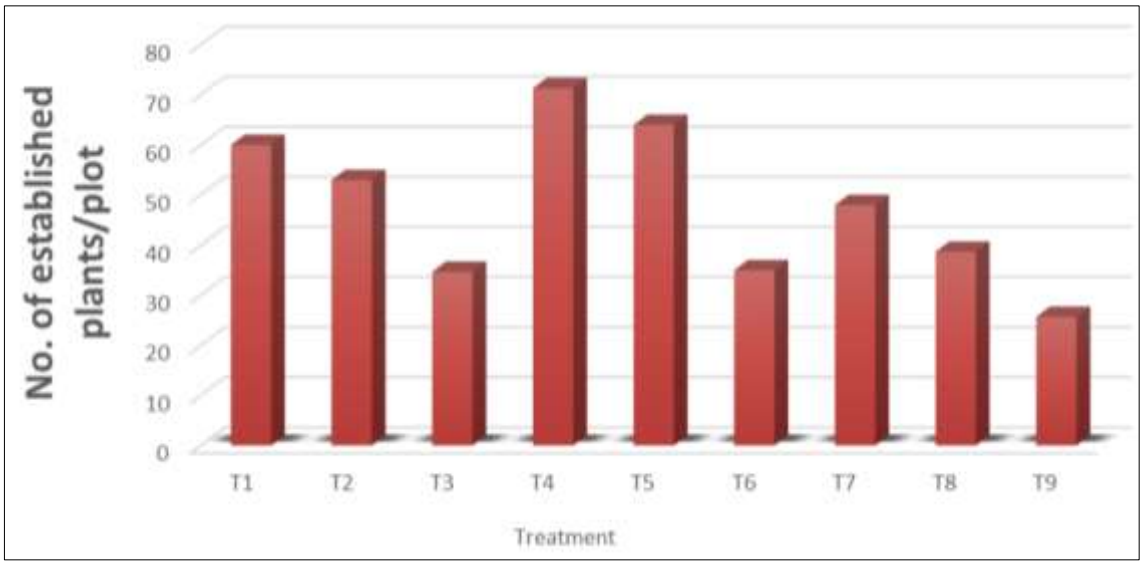

Fig 1: No. of established plants/plot of Water Spinach (*Ipomoea aquatica* Forsk.)

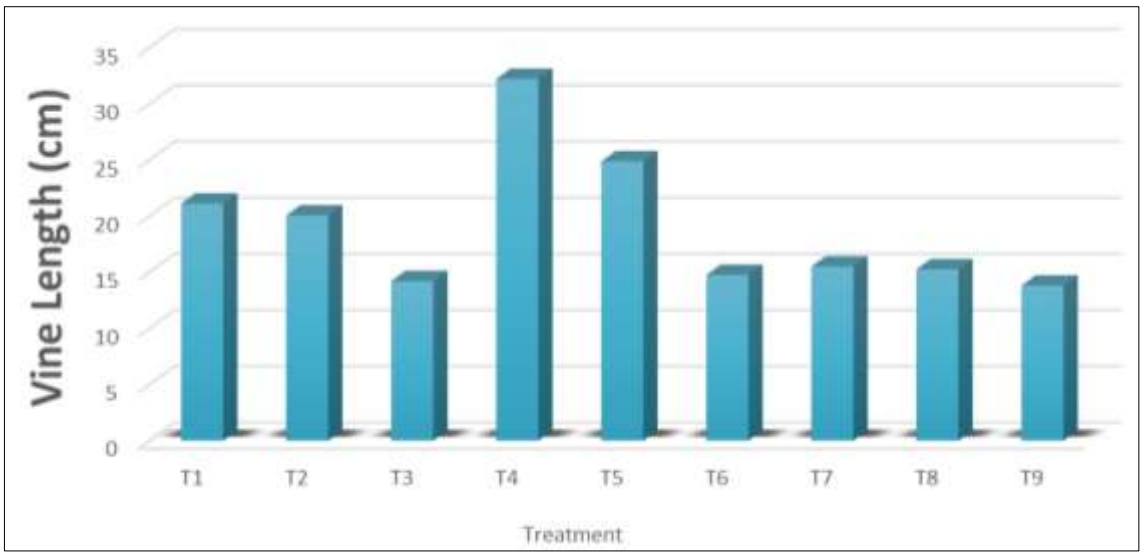

Fig 2: Vine Length (cm) of Water Spinach (*Ipomoea aquatica* Forsk.)

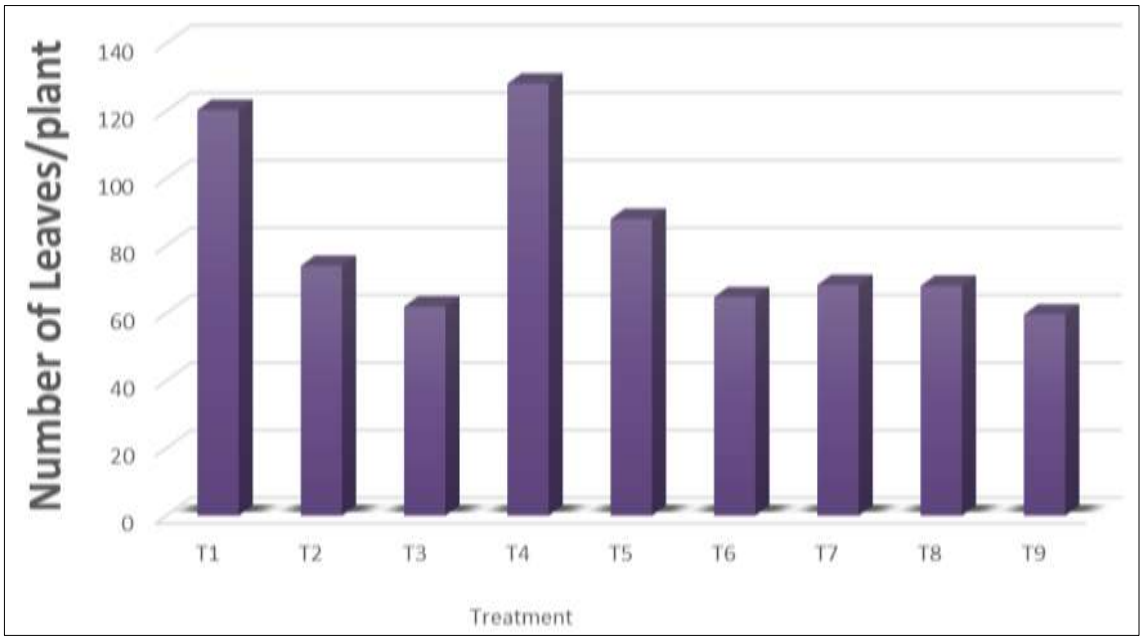

Fig 3: Number of Leaves/plant of Water Spinach (*Ipomoea aquatica* Forsk.)

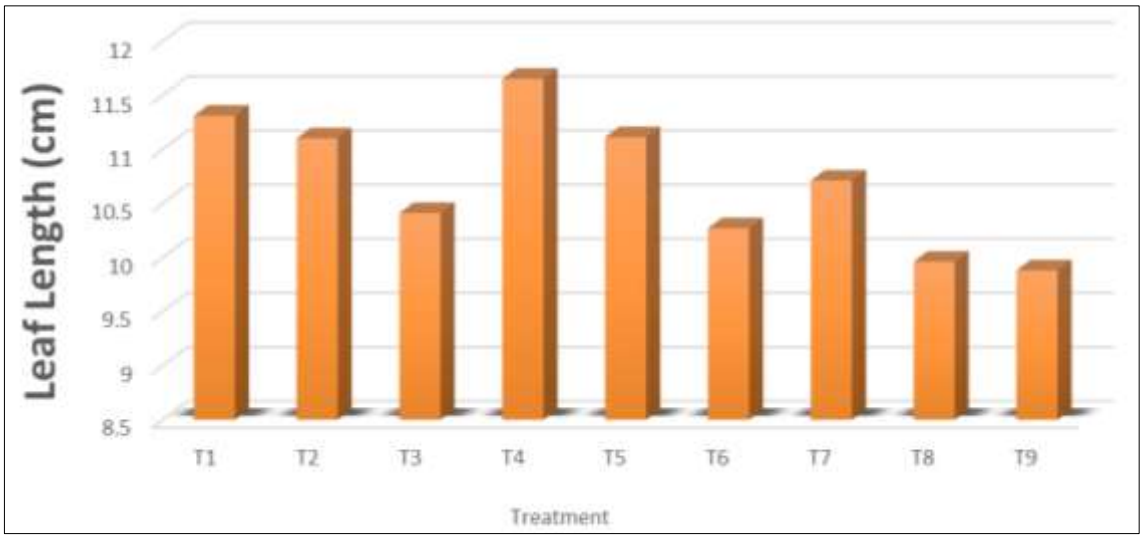

Fig 4: Leaf Length (cm) of Water Spinach (*Ipomoea aquatica* Forsk.)

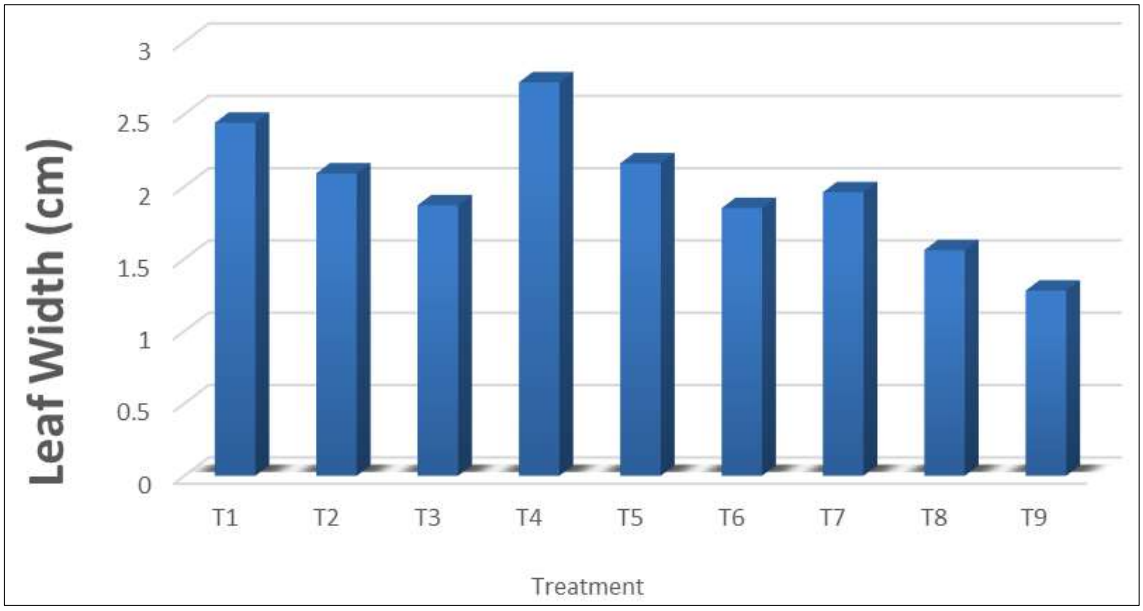

Fig 5: Leaf Width (cm) of Water Spinach (*Ipomoea aquatica* Forsk.)

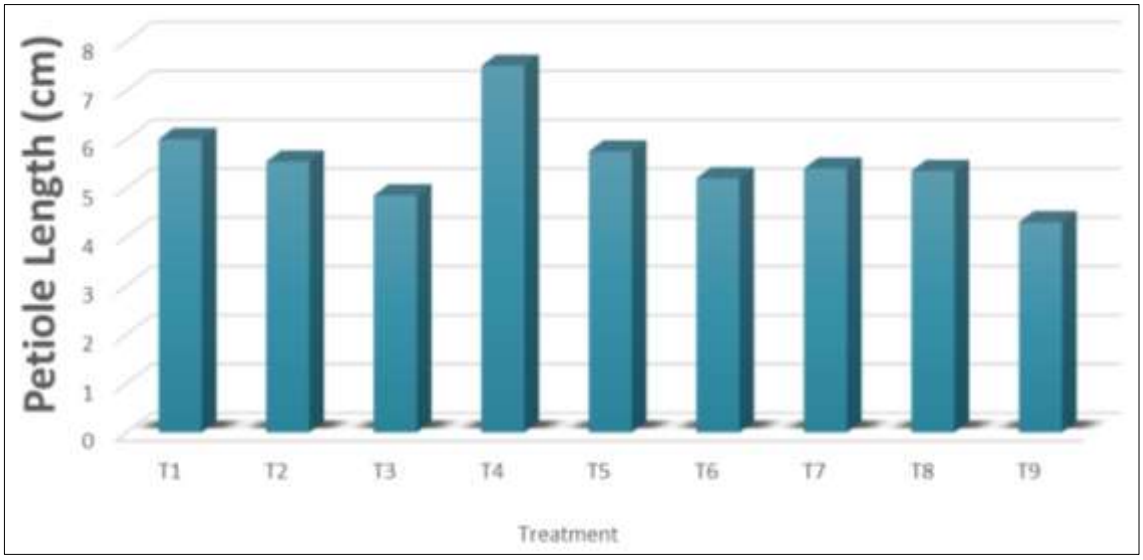

Fig 6: Petiole Length (cm) of Water Spinach (*Ipomoea aquatica* Forsk.)

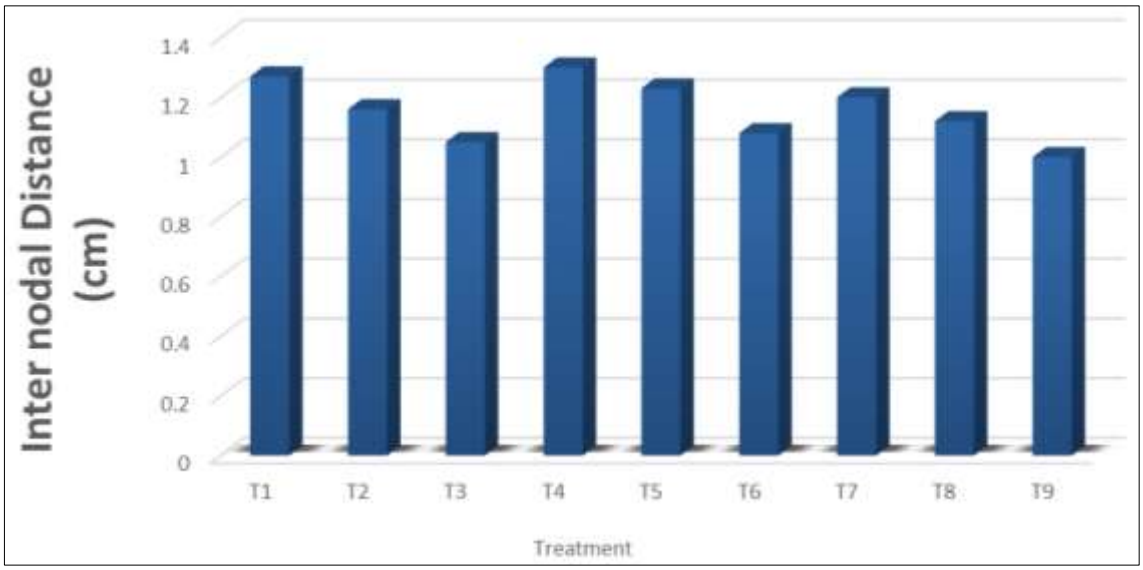

Fig 7: Inter nodal Distance (cm) of Water Spinach (*Ipomoea aquatica* Forsk.)

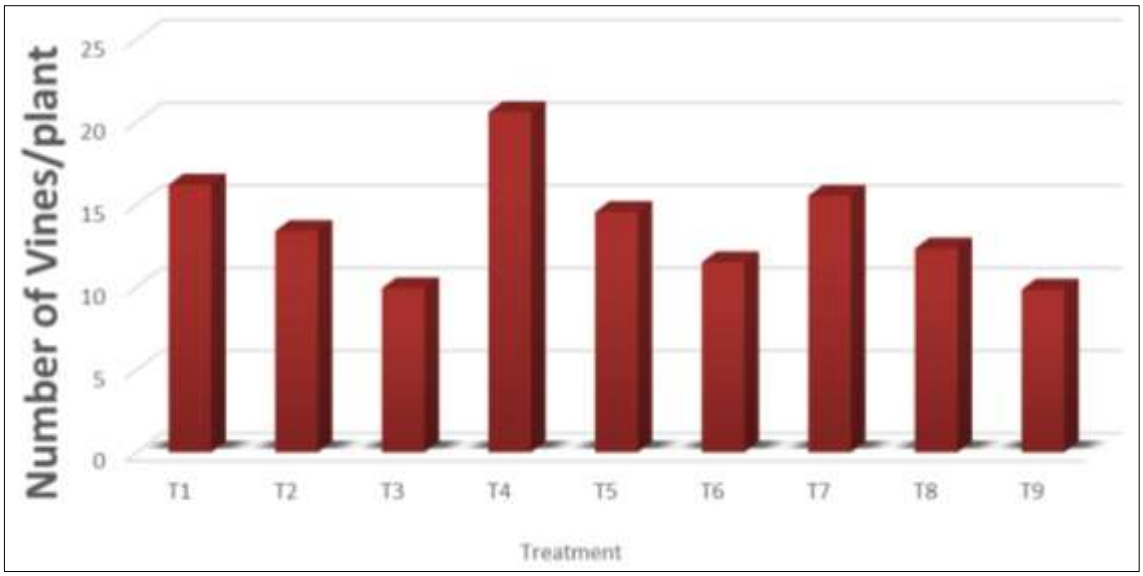

Fig 8: Number of Vines/plant of Water Spinach (*Ipomoea aquatica* Forsk.)

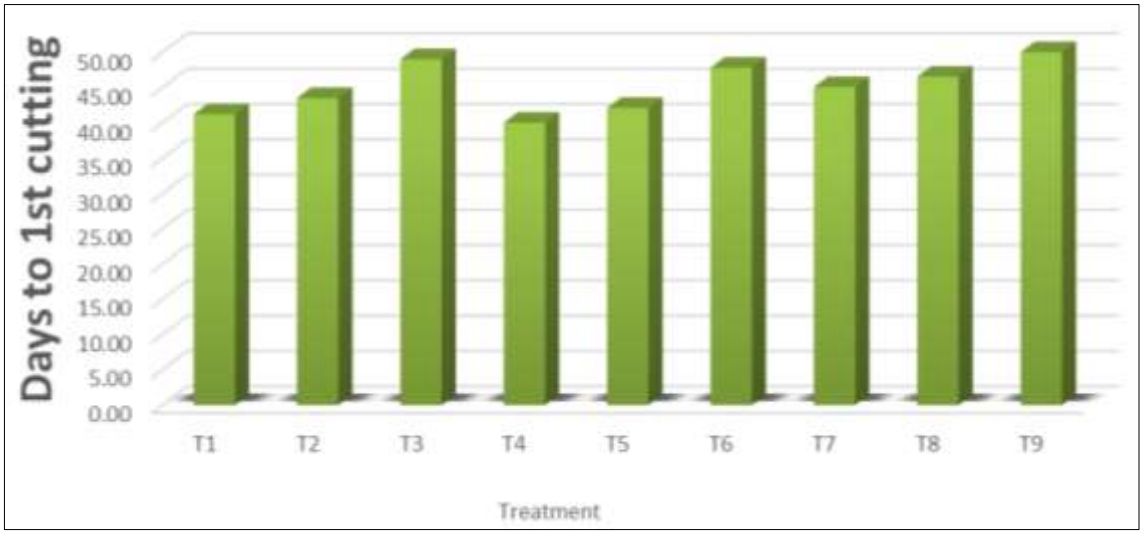

Fig 9: Days to 1st cutting of Water Spinach (*Ipomoea aquatica* Forsk.)

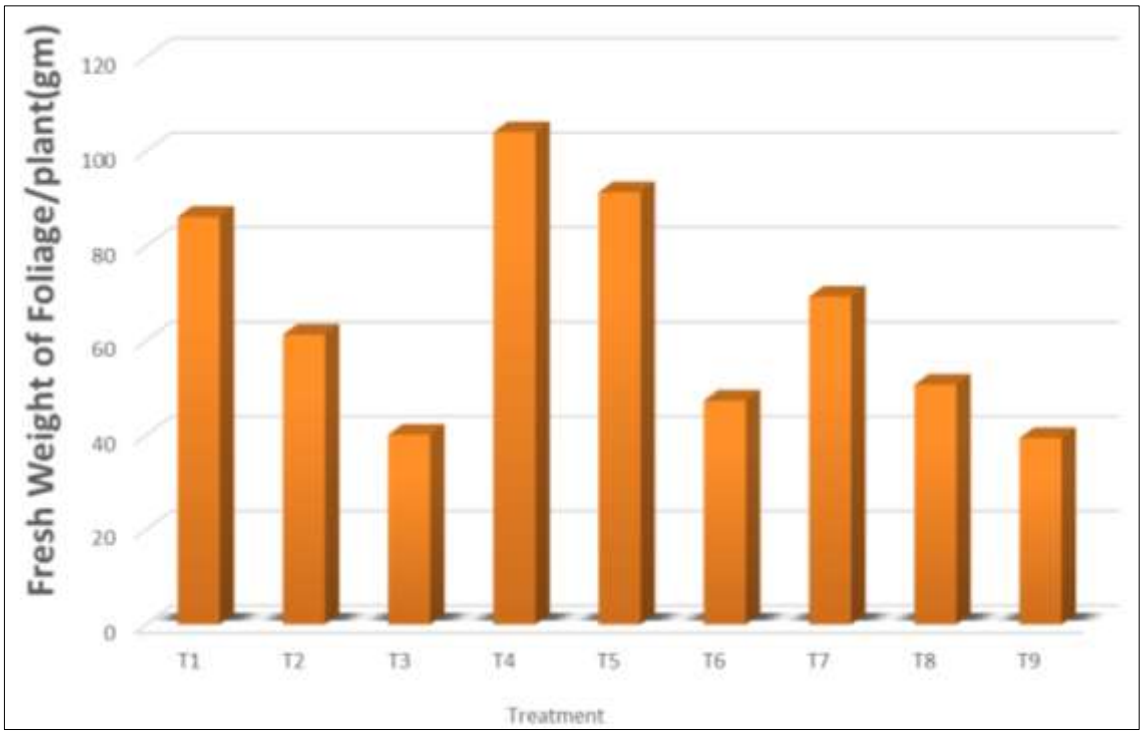

Fig 10: Fresh Weight of Foliage/plant (gm) of Water Spinach (*Ipomoea aquatica* Forsk.)

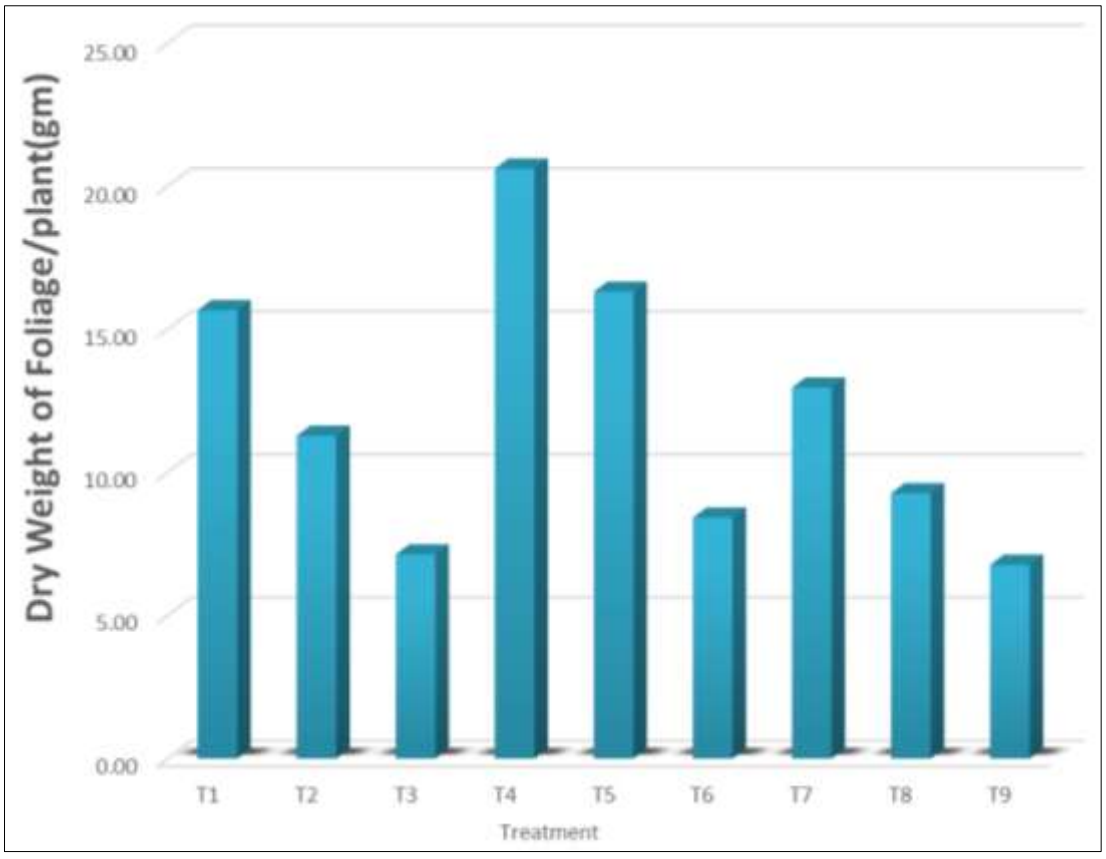

Fig 11: Dry Weight of Foliage/plant (gm) of Water Spinach (*Ipomoea aquatica* Forsk.)

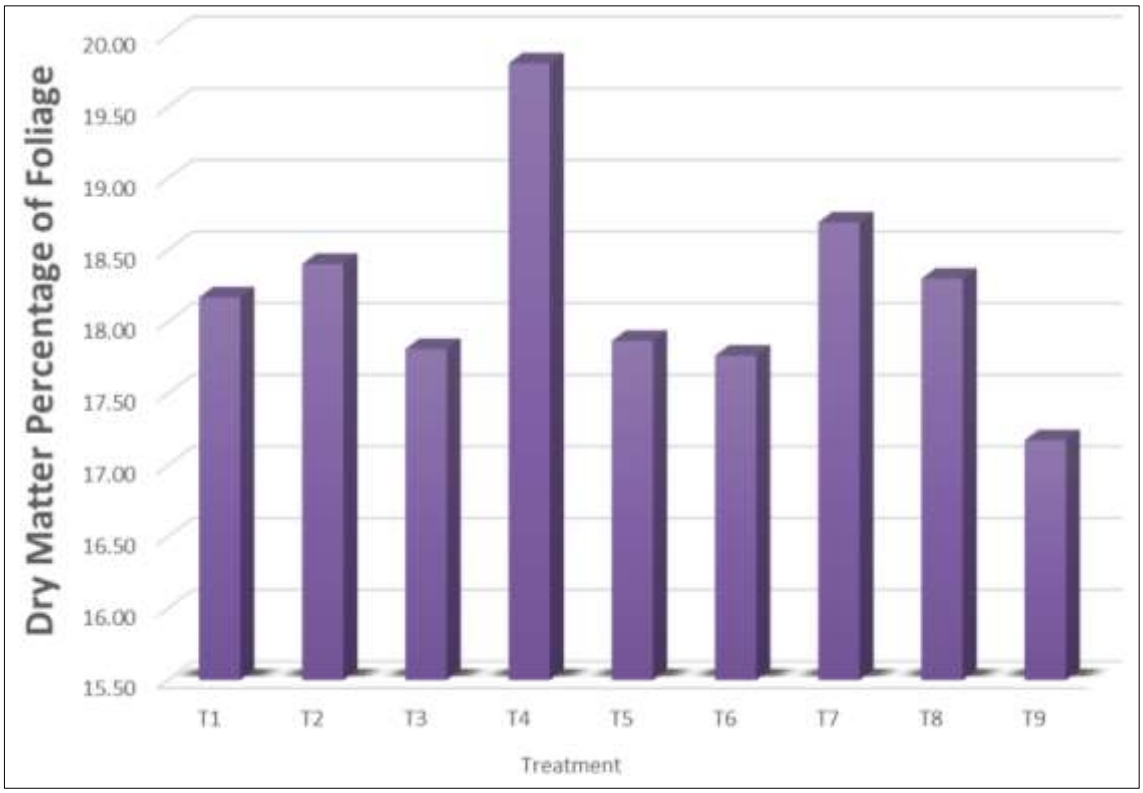

Fig 12: Dry Matter Percentage of Foliage of Water Spinach (*Ipomoea aquatica* Forsk.)

Conclusion

On the basis of present investigation, treatment T_4 (Planting through seedlings treated with GA_3 100 ppm) was found significantly superior for all the growth parameters of water spinach (*Ipomoea aquatica* Forsk.). Hence, it can be concluded for cultivation of water spinach.

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